

# REPORT DOCUMENTATION PAGE

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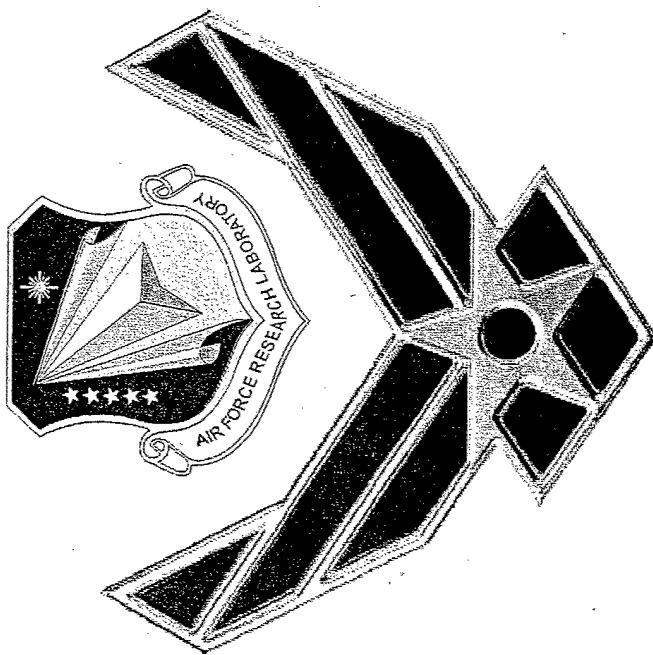
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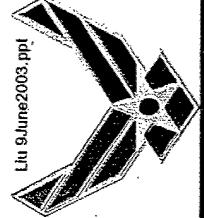
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# The Application of Fracture Mechanics to Estimate the Crack Length for Developing an Inspection Criterion

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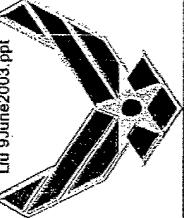
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## Objectives:

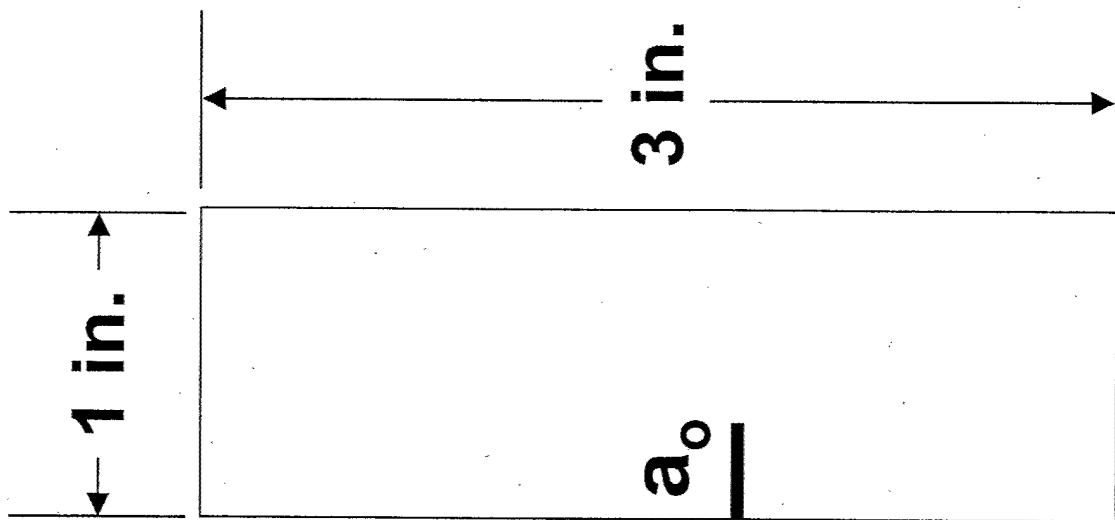
- Determine the Inherent Critical Initial Crack Size in a Particulate Composite Material for Developing an Inspection Criterion.
- Determine the Statistical Distribution Function of the Inherent Critical Crack Size.

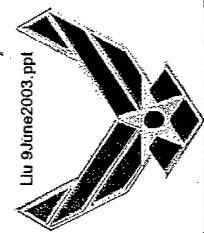


# Specimen Geometry



$$\begin{aligned}a_o &= 0.0 \text{ in.} \\&= 0.1 \text{ in.} \\&= 0.2 \text{ in.} \\&= 0.3 \text{ in.}\end{aligned}$$





# Crack Growth Equations

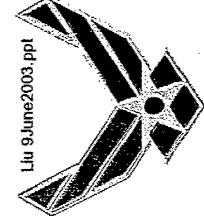


$$K_I = \sigma (\pi a)^{1/2} f (a/w)$$

$$f (a/w) = 0.7722(a/w)^3 + 0.9253(a/w)^2 + 1.095(a/w) + 1.005$$

$$K_{IC} = \sigma_c (\pi a_c)^{1/2} f (a_c/w)$$

$$da/dt = Q K_I^m$$



# Statistical Distribution Functions

$$F_X(x) = \Phi\left(\frac{x-u}{\sigma}\right) \quad \text{Normal Distribution}$$

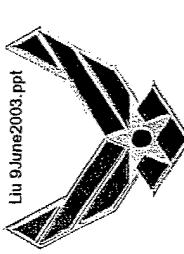
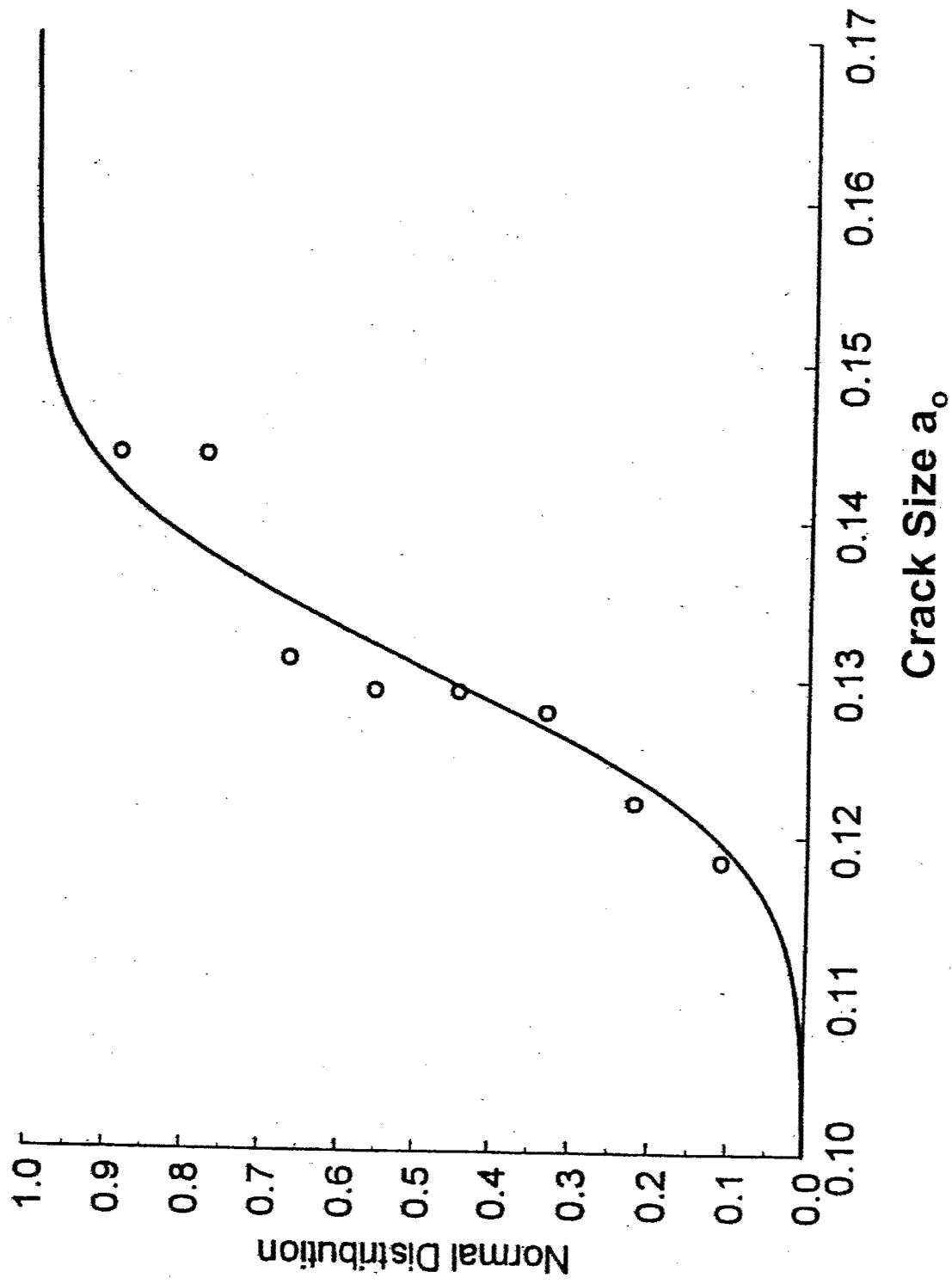
$$F_X(x) = \Phi\left(\frac{\ln x - u^*}{\sigma^*}\right) \quad \text{Lognormal Distribution}$$

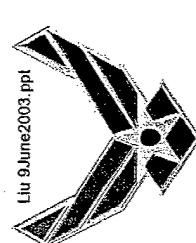
$$F_X(x) = 1 - \exp [-(x/\beta)^\alpha] \quad \text{Two-Parameter Weibull Distribution}$$

$$F_X(x) = \exp [-(x/v)^{-\kappa}] \quad \text{Second Asymptotic Distribution of Maximum value}$$

$$F_X^*(x) = 1 - F_X(x) \quad \text{Exceedance Curve.}$$

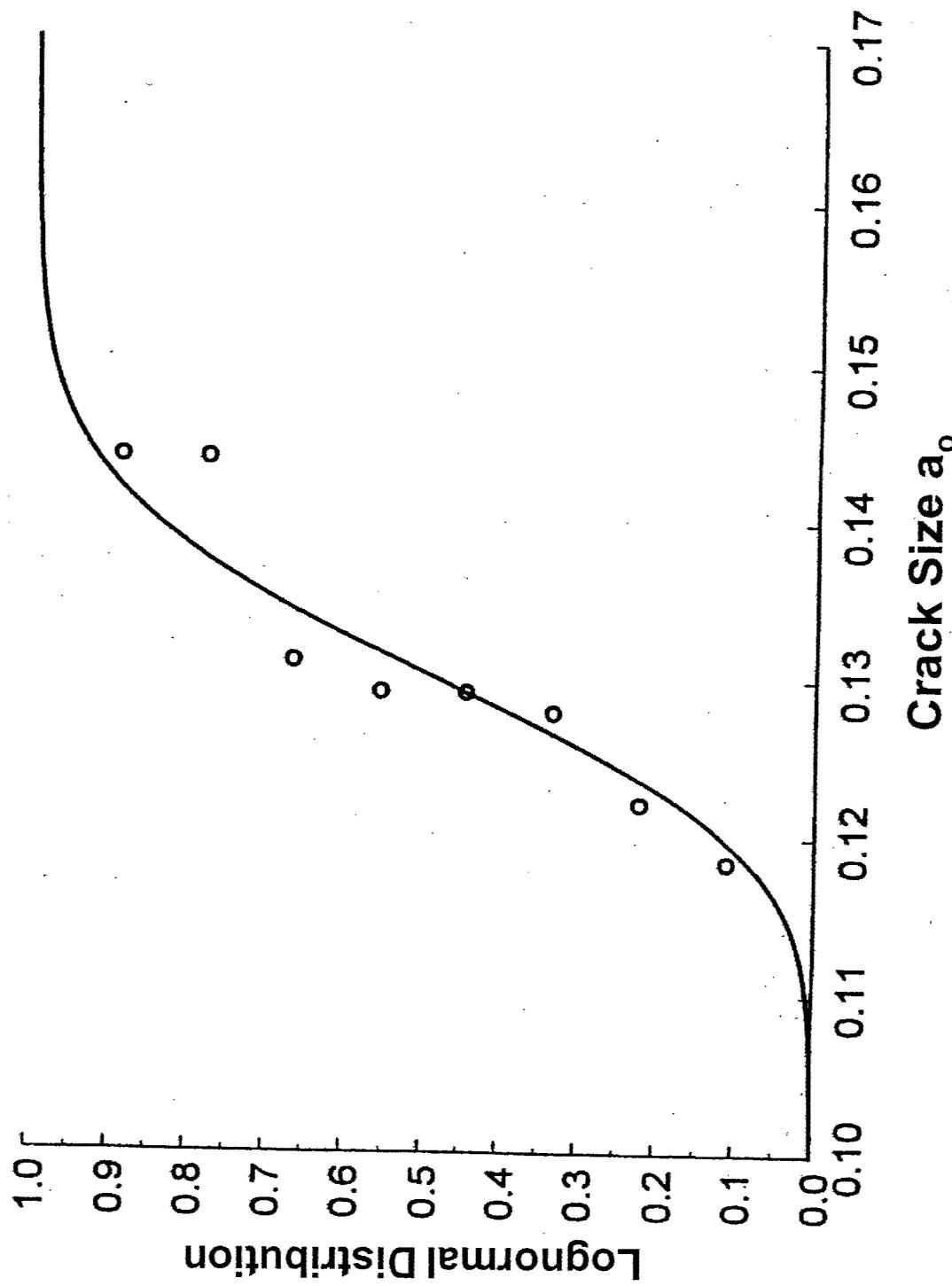
# Normal Distribution Plot for $a_o$

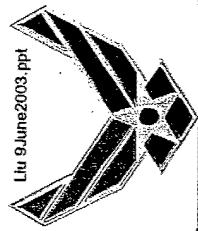




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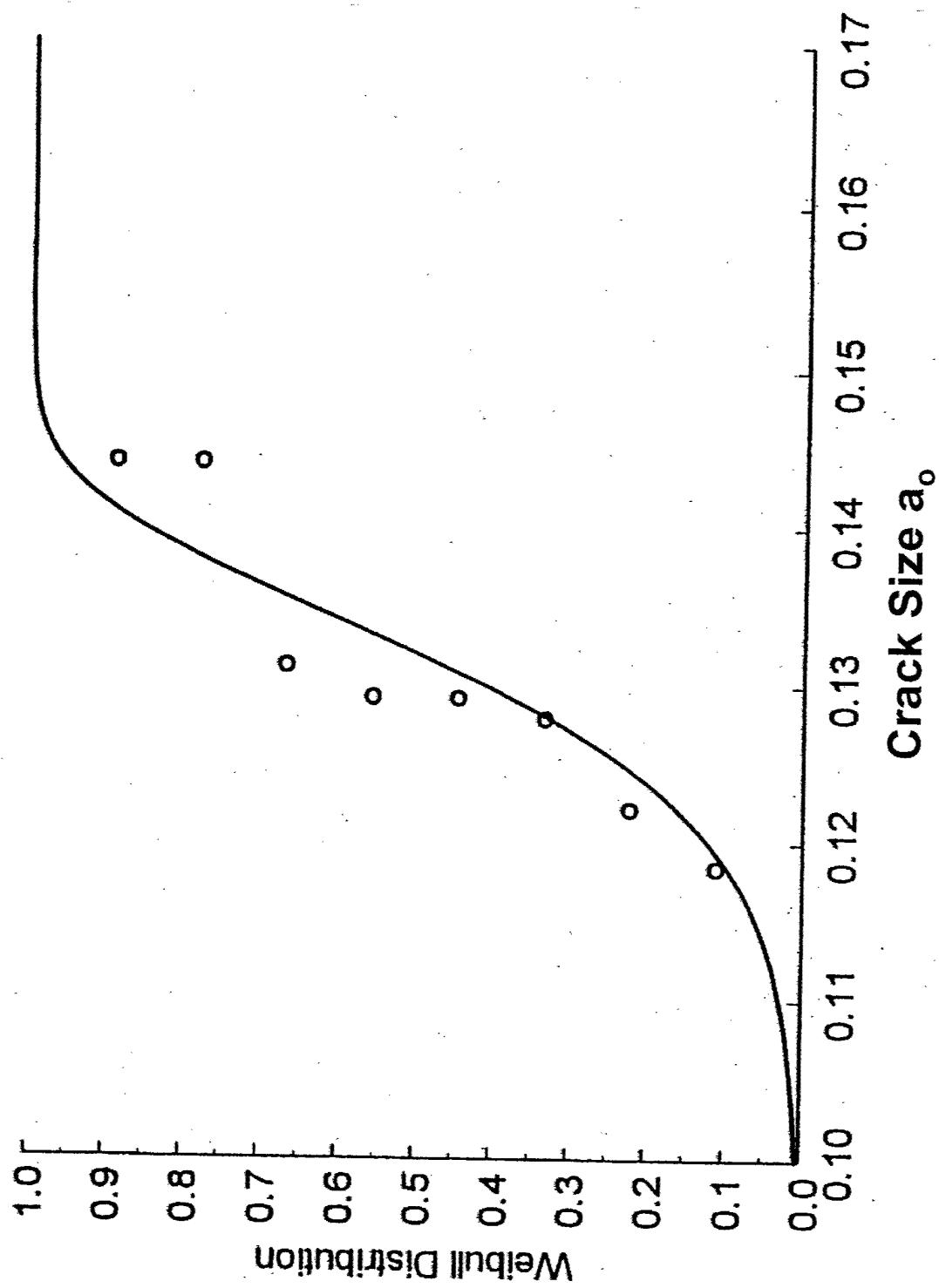
# Lognormal Distribution Plot for $a_o$

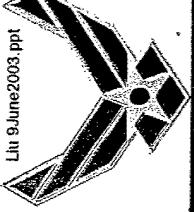




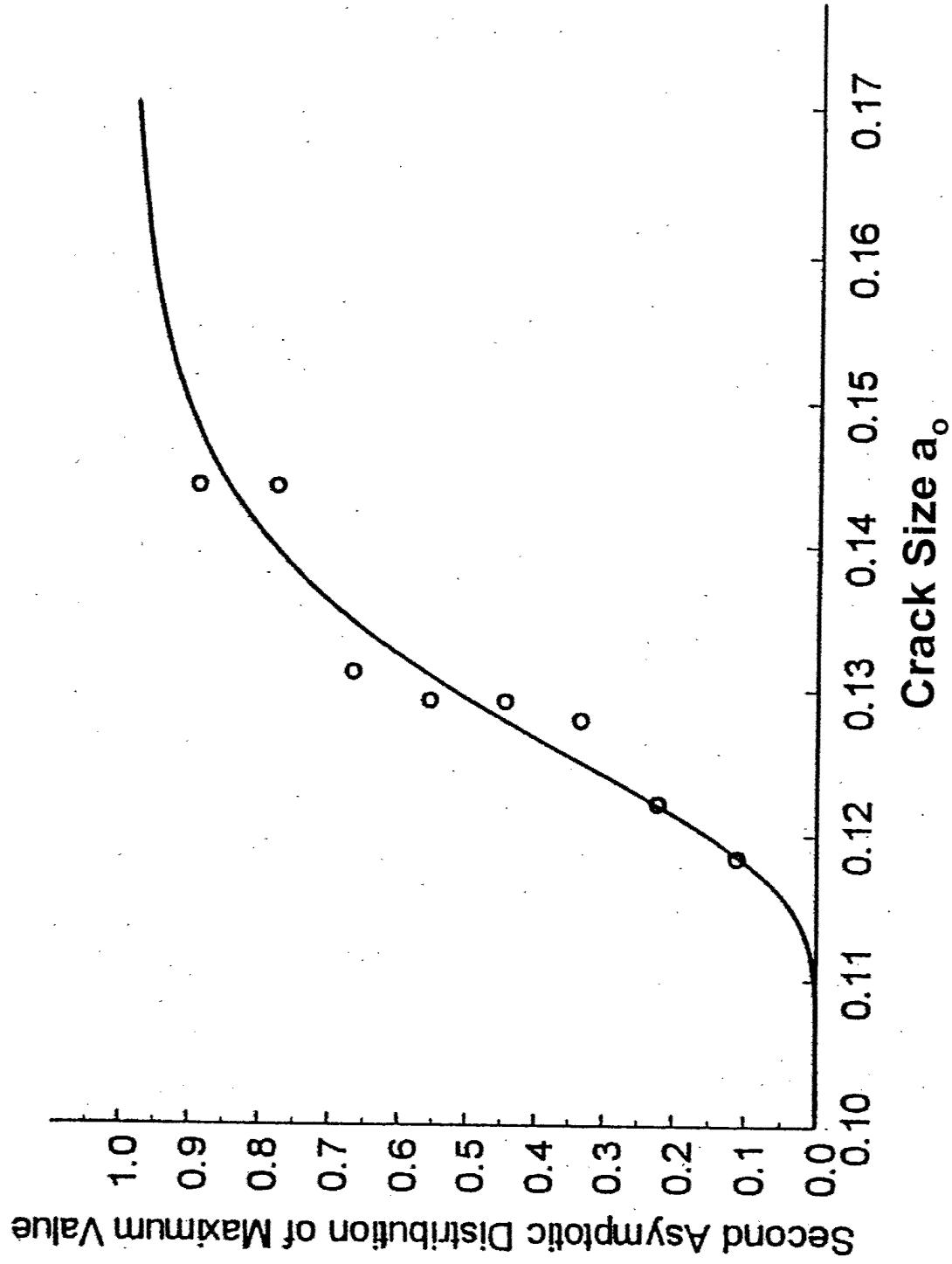
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# Weibull Distribution Plot for $a_0$





## Second Asymptotic Distribution Plot for $a_o$



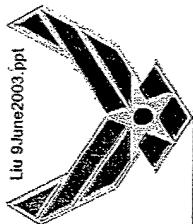


# Distribution Parameters for Normal, Lognormal, Weibull and Asymptotic Distributions



Strain Rate = 0.04 min<sup>-1</sup>

	$a_0$	$a$	$a_c$
$u$	0.1308	0.1344	0.1462
$\sigma$	0.0092	0.0090	0.0079
$u^*$	-2.037	-2.0092	-1.9242
$\sigma^*$	0.07021	0.06692	0.053961
$\alpha$	17.5546	18.4513	23.0450
$\beta$	0.1348	0.1383	0.1497
$k$	13.2524	13.8081	17.1205
$v$	0.1258	0.1295	0.1419

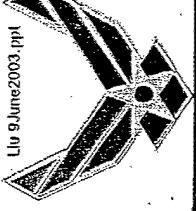


## Distribution Parameters for Normal, Lognormal, Weibull, and Asymptotic Distributions



Strain Rate = 0.727 min.<sup>-1</sup>

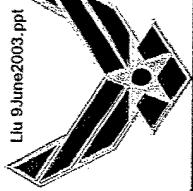
Strain Rate = 0.727 min. <sup>-1</sup>			
Parameters	$a_c$	$a^*$	$a_o$
$\mu$	0.12999	0.12131	0.11865
$\sigma$	0.00152	0.00159	0.00157
$\mu^*$	-2.04037	-2.10951	-2.13163
$\sigma^*$	0.01172	0.01315	0.01324
$\alpha$	80.1416	74.4660	74.4279
$\beta$	0.1308	0.1221	0.1194
$\kappa$	72.4100	70.8130	71.9883
$\nu$	0.1291	0.1204	0.1178



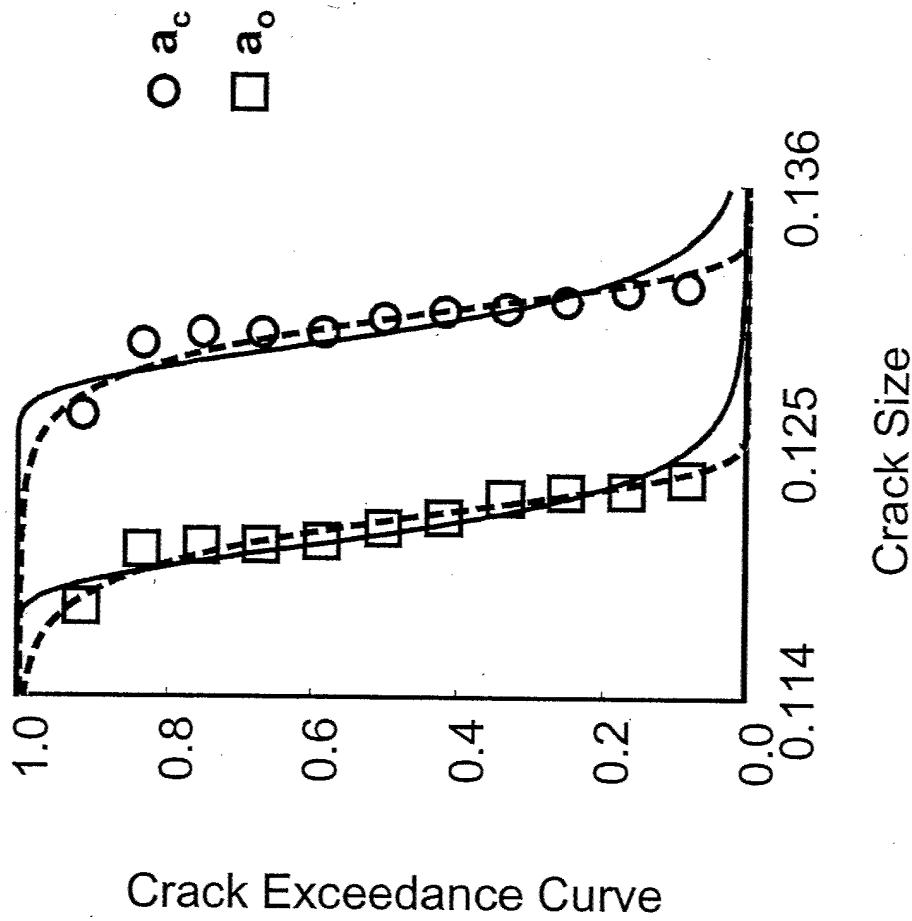
# Distribution Parameters for Normal, Lognormal, Weibull, and Asymptotic Distributions

Strain Rate = 18.182 min.  $^{-1}$

Parameters	$a_c$	$a^*$	$a_o$
$\mu$	0.15750	0.14735	0.14597
$\sigma$	0.00290	0.00296	0.00290
$\mu^*$	-1.84847	-1.91517	-1.92456
$\sigma^*$	0.01842	0.02008	0.01989
$\alpha$	53.6601	49.5994	50.0668
$\beta$	0.1590	0.1488	0.1474
$\kappa$	51.3708	47.7906	48.4144
$\gamma$	0.1559	0.1458	0.1444

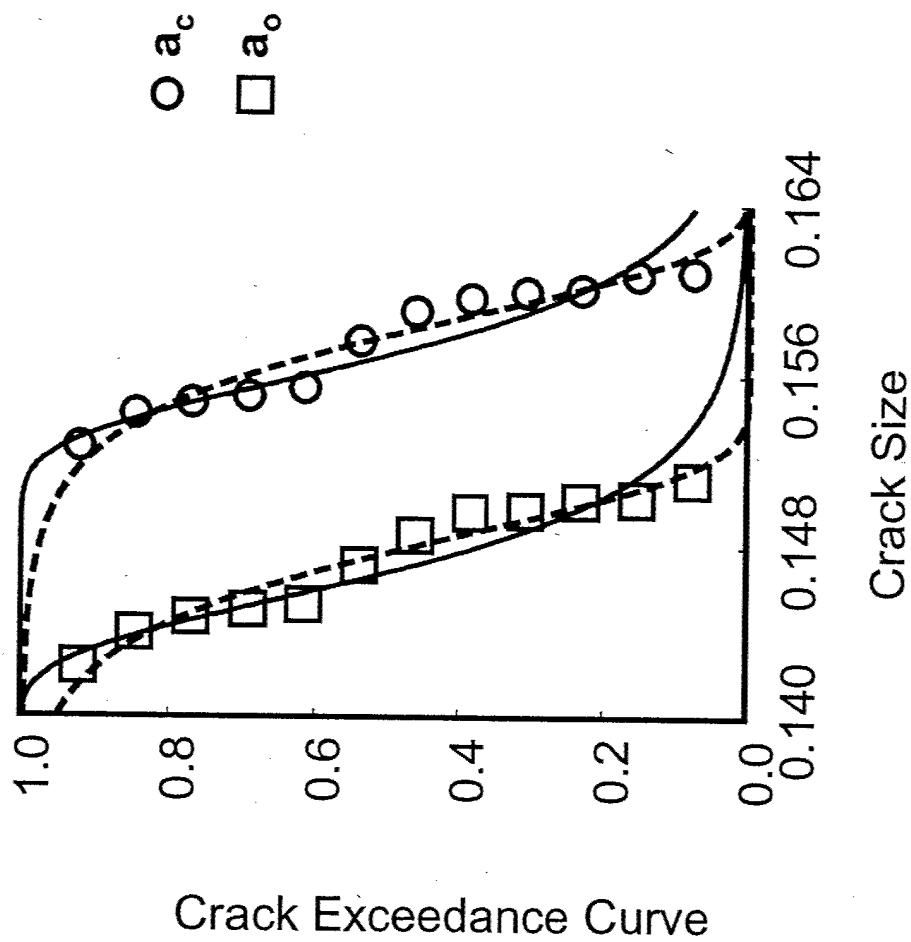


# Crack Exceedance Curves for Strain Rate = 0.727 min<sup>-1</sup>

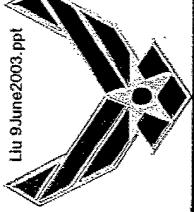


Solid Curves for Second Asymptotic Distribution and Dashed Curves for Weibull Distribution.

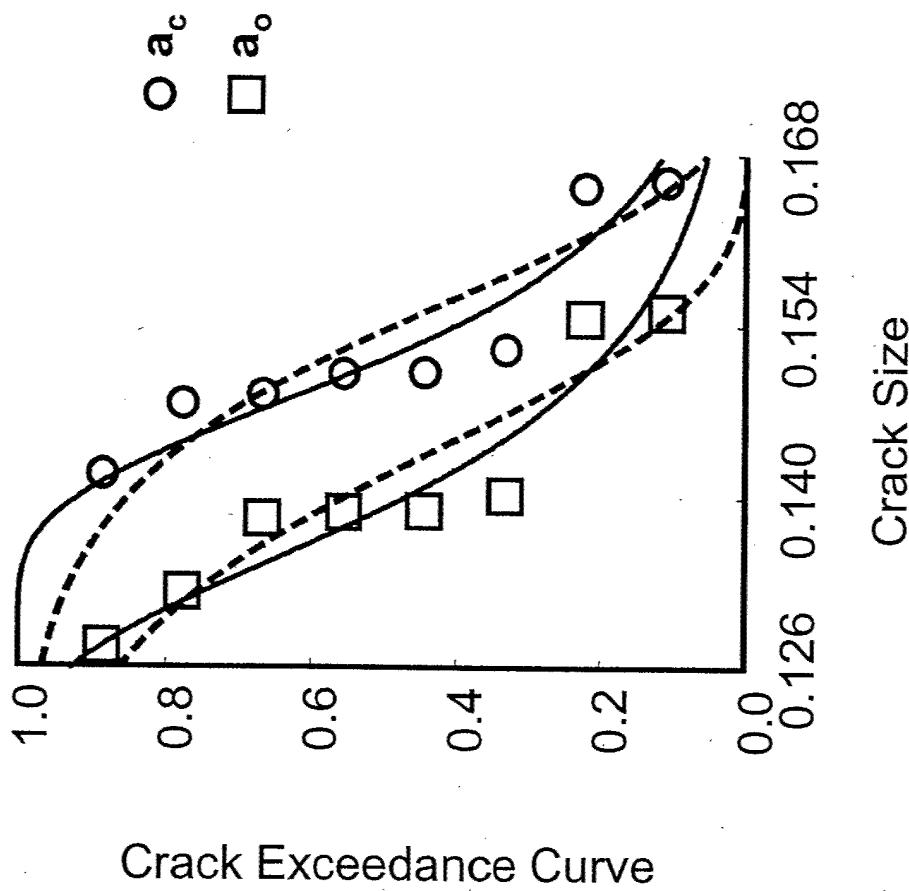
# Crack Exceedance Curves for Strain Rate = 18.182 min.<sup>-1</sup>



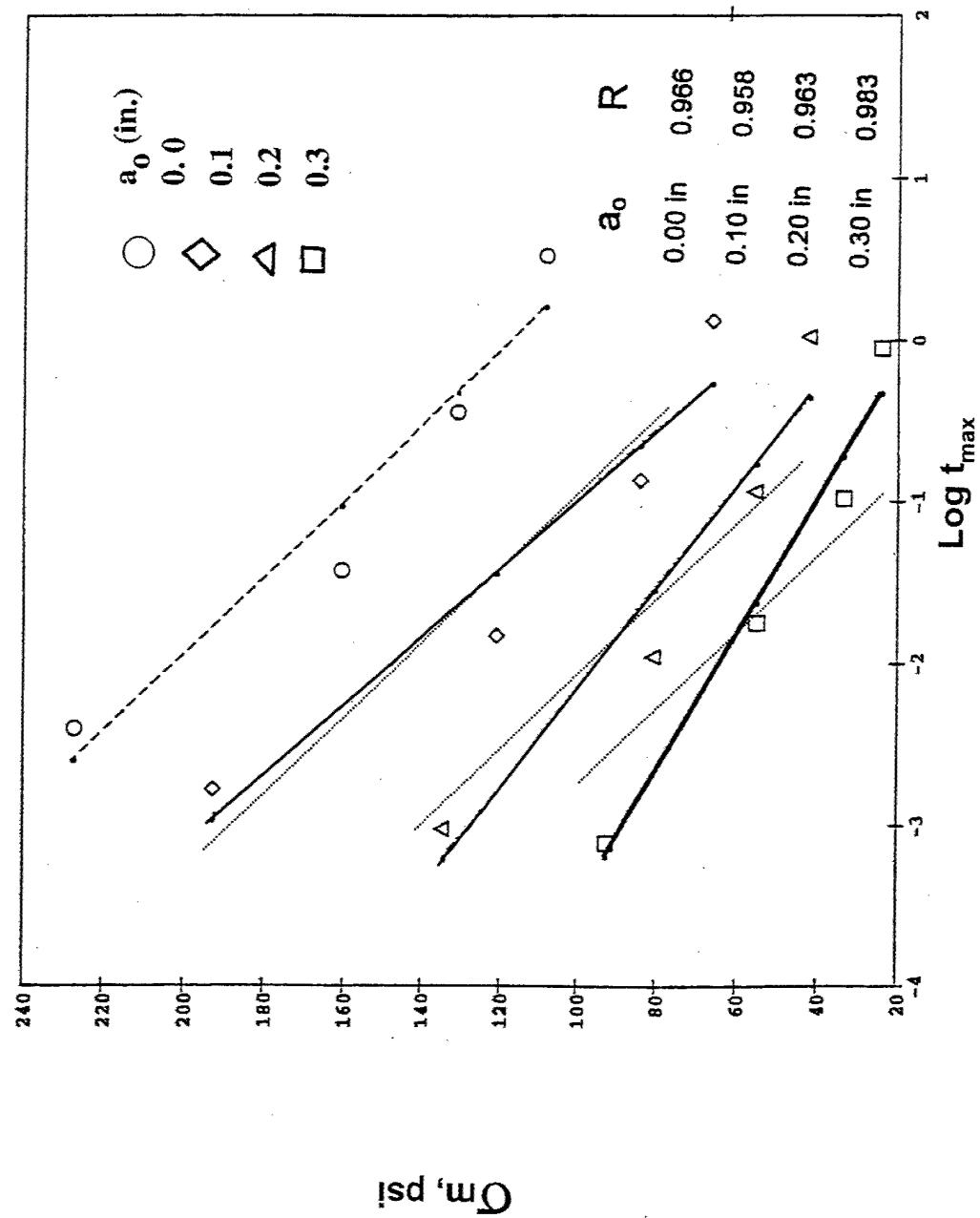
Solid Curves for Second Asymptotic Distribution and Dashed Curves for Weibull Distribution.



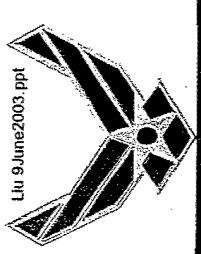
# Crack Exceedance Curves for Strain Rate = 0.04min.<sup>-1</sup>

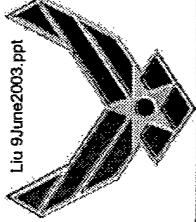


Solid Curves for Second Asymptotic Distribution and Dashed  
Curves for Weibull Distribution.



**Maximum Stress Vs Maximum Time**





## Conclusions:

- For the material studied, the estimate inherent critical crack size,  $a_o$ , is insensitive to the strain rate and the averaged value of  $a_o$  is 0.132 in., which compares well with experimental value.
- The inherent critical crack size follows the second asymptotic distribution of the maximum value.
- The estimated  $a_o$  should be used to develop the inspection criterion.

